Remarks

Reconsideration of this Application is respectfully requested.

Upon entry of the foregoing amendments, claims 1-9 are pending in the application, with claim 1 being the independent claim. Support for the amendment to claim 1 can be found throughout the specification, e.g., in paragraphs [0018] and [0021]. These changes are believed to introduce no new matter, and their entry is respectfully requested.

Based on the above amendments and the following remarks, Applicants respectfully request that the Examiner reconsider all outstanding objections and rejections and that they be withdrawn.

Misc. Matters

The Office Action of August 16, 2007 mistakenly referred to the Applicants filing a "request for a continued prosecution application (CPA) under 37 CFR 1.53(d)" on June 4, 2007. Further, the Examiner indicated that since a CPA is no longer permitted, the improper request for a CPS was being treated as a request for continued examination (RCE). For the record, Applicants bring to the Examiner's attention that the application filed June 4, 2007 was a request for continued examination (RCE) filed under 37 C.F.R. § 1.114, not a CPA as alleged by the Examiner. Acknowledgement of the nature of the June 4, 2007 filing is requested from the Examiner.

Rejection of claims 1-7 and 9 under 35 U.S.C. § 103

Claims 1-7 and 9 were rejected under 35 U.S.C. §103(a) as allegedly being obvious in view of Hwang *et al.* (*J. Mater. Chem. 11*:1722-1725 (2001)) in view of Smalley et al (*J. Nanosci. Nanotech 1*:81-86 (2003)). Specifically, the Examiner alleged that Hwang teaches a process of forming a carbon nanotube reinforced ceramic nanocomposite. The Examiner concedes that Hwang fails to explicitly provide for an extended sonication period of between 2 and 10 hours. However, the Examiner alleged that Smalley teaches the relationship between sonication time and CNT dispersion for periods up to 5 hours. Applicants respectfully traverse.

To establish a *prima facie* case of obviousness, the art cited by the Examiner must (1) teach all of the claim limitations; (2) provide a suggestion or motivation to those of ordinary skill in the art to make the claimed composition; and (3) reveal that one of ordinary skill would have a reasonable expectation of success in doing so. *See In re Vaeck*, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991); *see also* M.P.E.P. § 706.02(j). The United States Supreme Court, in *KSR International vs. Teleflex, Inc.*, 550 U.S. ___, WL 1237837 (April 30, 2007), further clarified the requirements for obviousness analysis under 35 U.S.C. 103(a). The Court noted that the analysis supporting a rejection under 35 U.S.C. 103(a) should be made ***explicit***, and that it was "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements" in the manner claimed. The Court specifically stated:

> Often, it will be necessary for a court to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was ***an apparent reason*** to combine the known elements in the fashion claimed by the patent at issue. To facilitate

> review, ***this analysis should be made explicit***. (*KSR*, slip opinion, page 14, *citing In Re Kahn*, 441 F. 3d 977,988 (CA, Fed. 2006) ([R]ejections on obviousness grounds ***cannot be sustained by mere conclusory*** statements, instead, there must be some articulated reasoning with some rational underpinning to support a legal conclusion of obviousness").

Hwang and Smalley do not teach or suggest the formation of chemical bonds between the carbon nanotubes and the matrix.

Amended claim 1 requires "wherein *chemical bonds* are formed between the carbon nanotubes and the matrix." Emphasis added. The extended sonification in the dispersion medium "functionalize[s] the carbon nanotubes," forming "functional groups. . . around the periphery of the carbon nanotubes in the dispersion." See [0018]. Additionally, the specification teaches that "[t]he sonification treatments are carried out . . . to induce the formation of chemical bonds between the carbon nanotubes and the matrix at the molecular level." See [0021]. The functional groups are then available to chemically bond with the surrounding matrix, increasing the strength of the ceramic powders as well as increasing the homogeneity of the carbon nanotubes in the matrix.

The invention as described in claim 1 differs sharply from Hwang. Hwang does not teach or suggest the formation of chemical bonds between the carbon nanotubes and the matrix. Rather, Hwang teaches the use of a *surfactant,* not sonification, to disperse the carbon nanotubes. Hwang notes that

> In the presence of surfactants, CNTs form co-micelle structures with surfactant molecules (*vide infra*) *via* strong van der Waals interactions and can be well dispersed in the aqueous solution.

Pg. 1722, col.2, last ¶. Thus, the carbon nanotubes are surrounded by surfactant while the nanotubes are sonicated. The presence of micelles which surround the carbon

nanotubes was highlighted in Hwang. For example, the carbon nanotube/surfactant micelles were demonstrated throughout the Hwang documents, e.g., the experiment represented in Fig.2, as well as the description on pg. 1723, col. 1, 2nd ¶-pg. 1724, col. 1, 1st ¶. The carbon nanotubes will not form chemical bonds with the ceramic matrix as required by claim 1 since they are surrounded by surfactants. Additionally, Hwang discloses sonicating for a relatively short amount of time (e.g., 10 minutes). Thus, even if surfactants were not present, chemical bond formation would not be induced. The absence of a chemical bond between the matrix and the homogenously dispersed nanotubes is exemplified by the fact that in the absence of surfactant, the carbon nanotubes "precipitate at the bottom of the aqueous solution." pg. 1722, col. 2, 3rd ¶. Hwang himself teaches that the salts will react with each other, not with the carbon nanotubes. See, e.g., "cross-linking (or polymerization) of silicates will occur," at pg. 1722, col. 2, last ¶. Smalley certainly does not teach the formation of chemical bonds, since Smalley does not even teach the use of water soluble salts. Thus, neither Hwang nor Smalley recognize that extended sonification will result not only in increase dispersion of the carbon nanotubes, but also facilitate the formation of chemical bonds. Thus, each and every element of claim 1 is not taught or suggested by Hwang, Smalley or a combination thereof. Since claims 2-7, and 9 depend from claim 1, each and every element of these claims is also not present in a combination of the cited references. For at least the above argument, the rejection of claims 1-7 and 9 under 35 U.S.C. §103 as allegedly being obvious by Hwang and Smalley should be withdrawn.

Hwang and Smalley do not teach or suggest nanotubes homogeneously dispersed in the ceramic matrix.

Additionally, claim 1 features that the nanotubes are *homogenously dispersed* in the ceramic matrix. The term "dispersed," as appreciated by one of skill in the art, as well as can be found in a dictionary, define the term "dispersed" to include: (1) to cause to break apart and go different ways; to send or drive into different parts; to scatter (*Webster's New International Dictionary of the English Language, 2nd Ed.*, G. & C. Merriam Co., p. 751 (1960)), (2) to cause to scatter and go off in various directions (*Funk & Wagnalls New Comprehensive International Dictionary of the English Language*, Publishers International Press, Newark, NJ, p. 368 (1982)), and (3) to cause to separate in different directions; to throw or drive about in all directions; to scatter (*The Compact Edition of the Oxford English Dictionary*, Oxford University Press, Oxford, England, p. 485 (1980)). Emphases added.

As discussed in the Applicants' Reply of June 4, 2007, Hwang does not disclose nanotubes homogeneously dispersed. The Examiner has alleged the carbon nanotubes are randomly distributed throughout the entire matrix, i.e., the nanotubes are dispersed in a microrod. This is in contrast to the description provided by Hwang. Hwang teaches

> "As shown in Fig 3(b), some CNTs sticking out of the end of a glass rod can be observed and are *roughly parallel* to each other. The fact that a glass rod contains many CNTs indicates that silicate-surfactant-CNT co-micelles have a *tendency to align in parallel* and so form large diameter glass rods."

Pg. 1723, 2nd col. last ¶ - 1724, 1st col., 1st ¶). This alignment is reiterated by Hwang when he states

> "These silicate encapsulated rods are initially randomly ordered (with some silicate-encapsulated particles), but eventually pack into micro-rod structure."

Pg. 1724, 1st col., 1st ¶, emphasis added. "Aligned", "roughly parallel" and "packed" carbon nanotubes are not "dispersed" carbon nanotubes. The aligned carbon nanotubes are not "scattered" or "sent off in different directions" within the microrods.

Additionally, the Examiner argued that the morphology of the claimed invention was similar to that of Hwang. Specifically, the Examiner compared Figure 5a of the present application to Figure 3a of Hwang. One of skill in the art would have recognized that these two electron micrographs were taken under different conditions, and thus cannot be directly compared. For example, Figure 5a is an electron micrograph is of a whole grain of ceramic powder. Figure 3a of Hwang is not of a whole grain of ceramic powder. Rather, the micrograph of Hwang is a representation of a micrometer sized rods placed into an epoxy resin. The resin was then cut into thin slices, and then viewed under an electron micrograph. Pg. 1723, col. 2, 2nd ¶. Thus, Figure 3a is a cross-section of a microrod. Thus, direct comparisons of morphology would be inappropriate. However, even if one was to compare the morphologies, one would be taxed to recognize any similarities between the two micrographs. As stated previously, the Hwang reference discloses carbon nanotubes surrounded by surfactant, and not bonded to the matrix. This is highlighted by Hwang when he points out that

> "the internal structures of these silicon dioxide glass rods contain many irregular holes. These holes are probably formed due to copolymerization of silicate-surfactant-CNT co-micelles with silicate-surfactant-carbon nanoparticles (or amorphous carbons)."

Pg. 1723, col. 2, last ¶. Thus, Hwang clearly indicates that the "holes", i.e., dark spots, on Figure 3a are not carbon nanotubes. It would be impossible to tell if the nanotubes are aligned as suggested by the Examiner. However, Figure 3b does indicate that the

carbon nanotubes can be observed, and that they are "roughly parallel to each other." Thus, both the text of Hwang and the figures of Hwang indicate that the carbon nanotubes are roughly aligned, and are certainly not homogeneously dispersed as featured in claim 1.

Since the present invention is directed to a method of making nanocomposite powders wherein the carbon nanotubes are *homogeneously dispersed*, then Hwang does not teach the invention as claimed. Smalley certainly does not teach the nanotubes homogeneously dispersed in a ceramic matrix, since Smalley does not even include a ceramic matrix. Thus, each and every element of claim 1 is not taught or suggested by Hwang, Smalley or a combination thereof. Since claims 2-7, and 9 depend from claim 1, each and every element of these claims is also not present in a combination of the cited references. For at least this additional argument, the rejection of claims 1-7 and 9 under 35 U.S.C. §103 as allegedly being obvious by Hwang and Smalley should be withdrawn.

Rejection of claim 8 under 35 U.S.C. § 103

Claim 8 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Hwang as applied above to claim 1, in further view of Chang (U.S. Pat. 6,420,293). Specifically, the Examiner alleged that Hwang teaches that the SiO_2-CNT powder is to be calcinated in an N_2 atmosphere at 1050°C, which falls between the claimed temperature range of 400-1700°C. The Examiner concedes that Hwang fails to explicitly set forth that the calcination of the ceramic matrix should be performed under a high vacuum. However, the Examiner alleged that Chang teaches that the heating of carbon nanotube materials at elevated temperatures in an oxidizing environment typically results

in chemical changes in the surface of the particles, and that both N_2 atmospheres and high vacuum environments are commonly utilized as non-oxidizing environments. Thus, the Examiner alleged that the high vacuum environment would be an obvious alternative to the nitrogen atmosphere in Hwang. Applicants respectfully traverse.

To establish a *prima facie* case of obviousness, the cited document(s) must teach or suggest each and every element of the claimed invention. Claim 8 is dependent on claim 1. Amended claim 1 requires that chemical bonds are formed between the carbon nanotubes and the ceramic matrix. Hwang does not teach or suggest that chemical bonds are formed between the carbon nanotubes and the ceramic matrix. Likewise, Chang does not teach or suggest that chemical bonds are formed between the carbon nanotubes and the ceramic matrix. Thus, neither Hwang nor Chang teach or suggest each and every element of claim 1, either individually or collectively.

Additionally, amended claim 1 requires that carbon nanotubes are homogeneously *dispersed* in said ceramic matrix. Hwang does not teach or suggest that carbon nanotubes are homogeneously *dispersed* in said ceramic matrix. Likewise, Chang does not teach or suggest that chemical bonds are carbon nanotubes are homogeneously *dispersed* in said ceramic matrix. Thus, neither Hwang nor Chang teach or suggest each and every element of claim 1, either individually or collectively.

Since claim 8 is dependent on claim 1, then each and every element of claim 8 is also not taught or suggested. For at least the above argument, the rejection of claim 8 under 35 U.S.C. §103 as allegedly being obvious by Hwang *et al.* in view of Chang should be withdrawn.

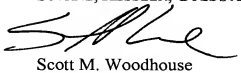
Conclusion

All of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicants believe that a full and complete reply has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Amendment and Reply is respectfully requested.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.



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